DESCRIPTION OF THE PREFERRED EMBODIMENTS

Enhanced reflectivity, durability, cost effectiveness and simplified production method can be achieved by eliminating major steps or processes used in previous arts for manufacturing reflective pavement markers. This invention is satisfying the above conditions.

This invention eliminate the process of metalizing the reflective face, eliminate the step of welding a backing sheet or a lens mounting sheet to the reflective face; eliminate filling the marker body (shell) with inert filled or fiber reinforced resinous material or welding a unitarily molded block with flattened base to a shell. This invention simply developed a process for monolithically forming a reflective pavement marker in one-stage or two-stage injection molding. This process comprises a mold that provide the means to form: the structural body, the cube corner reflective elements as well as load carrying interior wall means that allow integrally forming of said cube corner reflective elements.

Referring to FIGS. 1 through 6 represent one of the preferred embodiment of a monolithically formed one-piece reflective pavement marker designated by the number 200. Marker 200 is formed utilizing the process of the present invention, which comprises means to integrally injection mold the entire marker 200 including one reflective face 212 in one-step.

Marker 200 comprises, a top portion 214, two arcuate sides 216, two inclined planar faces 218 and 212 that are facing opposing traffics, with at least one face (212) is provided with means to integrally form cube corner reflective elements 230c on a designated cell like areas 230 within the inside surface of said face 212. Marker 200 also integrally includes textured and grooved planar base surface 220 with extended base portion 220a for added adhesion area. Various types, sizes or shapes of cube corner reflective elements can be utilized in this process of monolithically forming marker 200. Preferably, the height of each cube corner reflective element is about 0.0045 to .0125 inches. The commonly used standard cube corner elements can also be used.

The inclined planar reflective face 212 integrally has the interior cell like surfaces 230 defined by the load carrying interior wall means 310, which allow integrally forming cube corner reflective elements 230c freely protruding within hollow cavity air gaps 300 defined by said wall means 310.

Reflective cells 230 can be of any desired shape or size depending on the positions and shapes of the load carrying interior walls 310. Various reflective cell shapes and cube-corner reflective element sizes can be formed utilizing the method of the present invention.

The following U. S. Patents provide suitable exterior body shape, cell and or cube corner element designs, therefore, all of the following arts are incorporated as reference in their entireties: U.S. Pat. No. 4,726,706 and 5,927,897 to Attar and U.S. Patent No. 3,712,706 to Stam.

The outside planar surfaces of interior cells 230 are integral part of reflective face 212. Since interior cells 230 are defined by load carrying interior walls 310, the angular positions of these walls 310 provide the unobstructed ejection direction for injection molding of said protruding cube corner reflective elements 230c as integral part of the structural body of said marker 200. The reflective elements 230c within said interior cell 230 are isolated from adjacent cells by said load carrying interior walls 310, said interior walls 310 are tapered outwardly, thereby defining multiple hollow cavity air gaps 300. Hollow cavity air gaps 300 are directly beneath the interior of each cell 230. Each hollow cavity air gap 300 is formed corresponding to the size and interior shape of cell like surfaces 230 with the protruding cube corner reflective elements 230c. Hollow cavity air gaps 300 are integrally defined with their centerlines 500 forming an angle (ϕ) of about 80 to 120 degrees with respect to the outside planar surface of reflective face 212, thereby allowing uninterrupted injection molding process of marker 200 integrally including the cube corner elements 230c as well as the load carrying interior walls 310. The load carrying interior walls 310 are tapered forming an angle (A) equal or less than 5 degrees with respect to each hollow cavity centerline 500.

Hollow cavities 300a are used when the desired marker is to have only one reflective face, as shown in marker 200. Angular positions of hollow cavities 300a can provide the means to form cube corner reflective elements on the inside cell like surfaces of the top portion 214.

Both hollow cavities 300 and 300a will be tapered outwardly and open through the textured and grooved planar base surface 220.The load carrying interior walls 310 defining hollow cavities 300 and 300a can have fillet corners.

Some of the surfaces of load carrying interior walls 310 and the interior surface of top portion 214 can be formed with textures or arcuate grooves 310a, as in FIG. 6, for added reflectivity, surface opaqueness, and enhancing daytime appearance.

Marker 200 can be manufactured in one-step injection molding, either in one stage or two-stage color injection molding process, utilizing high impact resistance polymeric material.

A simple and efficient process of molding marker 200 can be achieved, by setting the mold's X-axis to be parallel to the planar reflective face 212 or parallel to planar base surface, thereby allowing all centerlines of the hollow cavity air gaps 300 and 300a to be closely aligned with respect to the Y-axis of said mold which is the open and close direction of said mold. To allow easy ejection cycle after the injection molding of marker 200, a small, outwardly draft angle is provided for the tapered surfaces of said load carrying interior walls 310, thereby defining said hollow cavity air gaps 300 and 300a and providing said uninterrupted injection molding cycles. This method of manufacturing marker 200 can be used to manufacture any pavement marker with the commonly used exterior geometry.

The hot injection molding of the polymeric material into the mold is preferably made through one or two apertures, located on a portion of the mold forming the base surface of the pavement marker. Thermoplastic such as high impact resistance acrylic, polycarbonate or any other high impact resistance polymers are suitable to be used in this process. Reflective face 212 can have either three raw, two raw or one raw of reflective cells 230, depending on the desired size, shape or height of marker 200 and the reflective cells 230 being used in this process.

For applications in sunny and hot environment, where bituminous hot-melt adhesive may be used, to agglutinate any marker to the roadway, the low melting point of such adhesive material may lead to adhesive failure known as cookie cutter effect, where a marker agglutinated to the pavement, may be forced by traffic impact load to move away from it's intended location on the roadway.

The science of material welding teach us that one of the primary variables to good adhesion of two surfaces is the total surface area to be wetted by the adhesive (welding) material, this area can be called the welding parameter, therefore, we can improve adhesion of marker 200 to a substrate, perhaps more effectively than the previous arts. This improvement in welding parameter can be achieved by using one of various arcuate shaped recesses within the base surface, each having discontinuous length. The grooves are perpendicular to traffic direction.

Each groove can have length of about an inch or less and textured surface, preferably by sand blasting the corresponding part of the tooling.

The depth of such grooves should about .04 to 0.10 inches. The length of each discontinuous grooves is about an inch, with textured surface. In addition, planar base surface 220 can have an integrally extended portion 220a, which extends beyond the periphery of marker body for added adhesive grip. Yet another mean to improve the adhesive welding parameter of the grooved planar base surface 220 is by capping the open ends of hollow cavities 300 and 300a by a corresponding shaped plate 185 with textured and grooved surface. Plate 185 can be used to plug a designated recessed area that can be provided within the base surface 220, such recessed area will include all the openings of the hollow cavities 300 and 300a, thereby allowing sonic welding of said plate 185 to said recessed area of the base 220.

FIG. 41 through 43 shows another reflective marker 15 that can be fabricated in accordance to the one-step process of present invention. Marker 15 can have two reflective faces 14, each with integrally formed, multiple reflective cells 14a.Each of cells 14a integrally having multiple cube corner reflective elements. Each cells interior inside a hollow cavity defined by multiple load carrying partition walls 14b.

The centerlines of the hollow cavities are near perpendicular to the planar base surface 16.

Preferably, various sizes of the reflective cube corner elements as described in Patent No. 3,712,706 to Stamm can be used, to minimize any ejection problems during fabrication.

In other applications where the desired marker to have two reflective faces with one or two colors, shorter body depth, lower height or maximum welding parameter at the marker base area.

Embodiments such as marker 10 and 10a of FIG.7 through FIG.14 can be formed in accordance to the method of the present invention.

FIGS. 7 through FIG.14 illustrate marker 10 comprises of two integrally formed near identical shaped marker 10a, welded or glued together. Marker 10 can have either transparent or partially pigmented body. Each marker 10a integrally comprises one inclined planar reflective face 110, a top portion 121, two arcuate sides 125, a planar rectangular base surface 150 with textured discontinuous grooves, said base surface 150 can have an integrally extended base portion 130 which extends beyond the periphery of the top portion of marker body, and back portion 160 forming perpendicular angle with respect to the planar base surface 150; said back portion 160 includes beaded surface and hollow cavities 165.

Various bead shapes or edges can be incorporated on the back portions 160, thereby fusing said back portions to each other during sonic welding.

The planar reflective face 110 integrally has interior cell like surfaces 115 with means to integrally form multiple of cube corner reflective elements 115c protruding from said interior cell surfaces 115. The interior cells 115 are open within hollow cavity air gaps defined by the load carrying interior wall means 155a. The hollow cavity air gaps 155 are open at the base surface 150. The centerline of each hollow cavity air gaps 155 forms an angle (α) of about 80 to 120 degrees with respect to the outside surface of reflective face 110. Each hollow cavity 155 separated from each other by means of outwardly tapered load carrying interior walls 155a.

It can be shown that marker 10 can have any commonly used shape or size and the reflective face can have either one raw or multiple rows of reflective cells, each cell having either hexagonal, rectangular, rhombic shape, as shown in FIGS. 35 to 37. When additional welding parameter (area) is needed for the base surface 150, the entire open ends of hollow cavities 155 can be capped by correspondingly shaped plate 180, as in FIG. 11, which can be welded onto a corresponding size and shaped recessed area that can be provided within the base surface 150. Marker 10 can be formed by means of welding the backsides 160 of two identical markers 10a.

The two markers 10a can be integrally injection molded with thin wedge connection 166.

Wedge 166 can be tore apart so that, two markers 10a with dissimilar colors can be welded at the corresponding back sides 160, forming marker 10. An alternative injection molding means can form each part 10a having a transparent reflective face segment 110 and the remaining segment of part 10a to be opaque. Marker 10 is manufactured by means of an injection molding process, integrally including the two parts 10a. This process can form each part with one or two dissimilar color segments.

The various embodiments according to the process of this invention can be provided with means to enhance durability and abrasion resistant of the exterior surface by applying a wear resistant film. Preferably applying this hard film by means of either reactive sputtering, utilizing pressure controller for accuracy, ion beam deposition methods or plasma enhanced chemical vapor deposition methods. This hard coat can be deposited on the reflective faces or the entire outside surface of the marker, said film can be a hard carbon film, silicon dioxide, aluminum oxide, and aluminum trioxide or titanium oxide film. Various coating methods can be utilized using hybrid plasma enhanced chemical vapor deposition processes; ion beam assisted sputtering or reactive sputtering.

In one of the plasma enhanced chemical vapor deposition methods, the carbon film is deposited on the surface of the marker by plasma decomposition of an alkane such as normal butane, methane, etc. with two, parallel spaced pure carbon electrodes, each powered by radio frequency power source, in a vacuum deposition chamber.

Under these conditions, the deposition of very hard carbon film can occur with good adhesion to marker surface. The deposition of carbon film can be achieved in one or multi layers within the same evaporative cycle, so that the first layer can have minimum hydrogen content, thereby adhering tenaciously to the substrate surface, that is to the surface of the pavement marker. Some belt driven or sequel tools, such as Novellus or Rohwedder AG methods may be available for semi-continuous production coating.

Alternatively, a hard and transparent aluminum oxide, silicon dioxide or titanium oxide film can be deposited on the reflective marker outside surface by using reactive sputtering assisted with pressure controller that would maximize the deposition rate allowing much faster and consistent rate of deposition of the a hard carbon, aluminum oxide or titanium oxide film with good adhesion to marker surfaces.

Another alternative means for a multi-layer hard carbon film deposition with good adhesion to substrate and without any polymeric prime coat is by ion beam sputtering in one or two stages, thereby having a soft carbon prime coat for good adhesion followed by hard carbon film.

To achieve maximum adhesion of such hard coating, the surface of the marker may be cleaned either chemically or with ion etching prior to applying the carbon film.

By gradually lowering the hydrogen pressure in the chamber and subsequently reintroducing hydrogen gradually to the plasma decomposition process of a gas, such as argon gas, a buffer film coating of carbon can be attained, immediately followed by a harder carbon film coat with higher hydrogen content thereafter to be deposited on the marker surface.

The process of the present invention can also be utilized to make other roadway markers, such as barrier delineators as well as temporary markers and mini marker for insertion into metal-based markers, such as used in snowy regions.

FIG. 15 (Prior Art 15) illustrates a schematic view of a typical L shaped delineator. This delineator made having either extruded or injection molded body 1, and two reflective strips 2 attachments, each with multiple cube corner reflective elements, said strips 2 adhered onto the top part of said body.

FIG. 16 (Prior Art 16) illustrates another delineator or temporary marker. This type of temporary marker is usually made of two parts, a body with multiple of hollow cavities 3, and at least one reflective plate attachment 4.

The process of the present invention can integrally form the entire delineator or temporary roadway marker's structural body including the cube corner reflective elements by means of one single injection molding cycle. Such delineator or temporary roadway marker made of one type or two types of high impact and tear resistant thermoplastics.

At least the reflective face portion integrally made of optically clear thermoplastic, including the cube corner reflective elements.

The illustrated embodiments in FIGS. 17 through 24 exemplify few delineators and temporary markers that can be manufactured according to the process of present invention.

FIGS. 17 and 17b show one of the preferred embodiments of a delineator 2. Delineator 2 is manufactured using means in accordance to the present invention. FIG. 17b in particular shows the two sides 2a and 2b of delineator 2, within the proximity of their position while being ejected during the injection molding process of said delineator 2. Each side 2a comprises a planar base portion 25a with grooves and a vertically positioned reflective face portion 20a. Base portion 25a is planar and can have few holes pierced through its surface, said surface is near perpendicular to face portion 20a. Face portion 20a is having two distinct sides, an interior side and exterior side. Both sides of face portion 20a are integrally partitioned into multiple of cell like shapes 22a. Cells 22a having planar surfaces on the exterior side, said planar exterior surfaces separated from each other by raised load carrying partitions walls 23a.

Cells 22a have interior surfaces with means for including and integrally forming multiple of cube corner reflective elements. The interior surfaces of the cells 22a are isolated from each other by the interior extension of partition walls 23a, said interior extension of walls 23a having wedge shaped top segment, means for allowing said partition walls to be sonically welded to the corresponding walls of the delineator's opposing side 2b.

Side 2a can be formed having periphery walls 24a defining the face portion 20a, and providing means to interlock with the corresponding walls 24b on the integrally formed opposite side 2b. Periphery walls 24a can also be integrally formed with textures or beads on its inside surface to partially fuse with said opposite walls 24b on side 2b of delineator 2.

The fusion of periphery walls 24a and 24b as well as partition walls 23a and 23b can be achieved by means of sonically welding the two sides 2a and 2b of the delineator 2. Similarly, side 2b comprises top face portion 20b, and a planar base portion 25b. The face portion 20b having similar cell like shapes 22b corresponding to the opposing side 2a of delineator 2.

Cells 22b are isolated from each other by the load carrying raised partition walls 23b. Each cell 22b having an interior surface with means to integrally include multiple of cube corner reflective elements.

The interior portions of the partition walls 23b are integrally formed with means for having the top segment fuse to the corresponding wedge shaped top segments of walls 23a of side 2a.

Sides 2a and 2b are integrally injection molded with wedge shaped ties 28, said ties 28 can be folded or split apart, thereby allowing the two sides 2a and 2b to interlock and/or sonically welded to each others interior side. After the two sides 2a and 2b are interlocked or welded, air gaps will be retained between the inside surfaces of each two opposing cells 22a and 22b, thereby allowing maximum retro reflectivity on two opposing traffic paths, via the freely protruding cube corner reflective elements within the interior surfaces of said cells 22a and 22b of sides 2a and 2b.

Various types of interlocking means, welding methods, and types of cube corner reflective elements and method of forming the same are available and can be incorporated in the process of forming delineators or temporary roadway markers or low profile markers, in accordance to the present invention. Descriptions of suitable cube corner reflective elements are provided in U.S. Pat. No. 3,712,706 to Stamm; U.S. Pat. No. 3,922,065 to Schultz; and U.S. Pat. No. 4,588,258 to hoopman, all of which are incorporated herein by reference in their entireties.

Any desired marker size or geometric shapes of each reflective cell can be incorporated in the injection molding process of forming the marker in accordance to present invention.

FIG. 35 thru 37 shows various reflective cell shapes and sizes of cube corner reflective elements.

FIG. 18 illustrate an isometric view of another preferred delineator 30, said delineator 30 can be injection molded in one piece with two sides 30a and 30b, in accordance to the process of the present invention. Delineator 30 has fewer partition walls 33 on each side, thereby allowing the formation of larger reflective cells 32 on both sides 30a and 30b, of said delineator 30. Each side 30a and 30b has a planar and grooved base surface 35.

FIG. 19 shows an isometric view of yet another delineator 40, preferably for use on the top or sides of concrete barriers, such barriers are commonly used to separate two directional traffics.

The two sides 40a and 40b of delineator 40 have no interior partition walls. Each side has a reflective portion 41, integrally including means to form cube corner reflective elements on the interior surface, and grooved planar base surface 45. By sonically welding the two integrally connected sides 40a and 40b at the beaded interior surfaces of the periphery walls 44, thereby delineator 40 is formed.

FIGS. 20 through 24 illustrate yet another novel structure that can be manufactured using the means in accordance to the process of present invention. In FIG. 20, there is shown a preferred embodiment of a temporary roadway marker 50 integrally formed in accordance to the present invention.

Temporary marker 50 comprises means for integrally injection molding the two sides 50a and 50b near identical to each other. Each side is having an upper segment 58 that resemble a handle bar, which will be called handle bar 58 from hereon, and a lower body 52.

Body 52 is having two arcuate sides 54, an inclined planar face 51 with two rows of multiple reflective cell like areas 51a on the interior surface of said planar face 51.This two rows of cell like interior areas 51a are provided with means to integrally include multiple cube corner reflective elements, said interior surfaces of cells 51a are open within hollow cavity air gaps 56 and 56b defined by means of load carrying partition walls 53. Body 52 also integrally includes a backside 57, said backside 57 with beading means for sonically welding the opposing sides 50a and 50b, thereby forming temporary marker 50. The two sides 50a and 50b are integrally injection molded with a connected thin ties that are provided at the upper periphery of handle bar 58.

FIG. 24 shows an isometric view of one side 50b of temporary marker 50, illustrating the planar base surface 55, integrally including one row of multiple hollow cavities 56. Hollow cavities 56 are open directly beneath the lower row of cells 51a, thereby allowing means to form cube corner reflective elements on the interior of said lower row of cells 51a. Also shown in FIG. 24, the backside 57, which consist of two segments 57a and 58b. Segment 57a is the backside of lower body 52, and the upper segment 58b is the backside of the handle bar 58 of side 50b of said temporary marker 50.

Segment 57a having textured planar surface that can be provided with beads so that it can be welded to the opposite side 57b, also shown multiple of hollow cavity air gaps 56b, which are open through said segment 57a. Hollow cavities 56b are open directly beneath the upper row of reflective cells 51a, thereby providing the means to integrally form multiple of cube corner reflective elements on said inside surfaces of upper row of cells 51a.

The upper segment 58b is the interior surface of handle bar 58. Segment 58b is also provided with means to integrally forming multiple of cube corner reflective elements bounded by raised periphery edges 59, said periphery edges 59 provide means to weld the two sides of handle bar 58, of said marker 50.The out side planar surfaces of the cells 51a can be either continuous part of the inclined planar face 51, or slightly recessed bellow the outside extensions of the load carrying walls 53. When the two sides 50a and 50b are sonically welded fusing the textured or beaded backsides, an air gaps will be retained, both in the upper handle bar 58 and the lower body 52, thereby providing retro reflectivity, both from the handle bar segment and from the lower body segment, and on two opposing traffic paths.

Both, the handle bar segments 58 and the lower body 52 can be integrally formed from highly transparent and resilient plastic. Temporary marker 50 can also be injection molded without the handle bar segment 58, thereby having a low profiled mini reflective marker with a height of about 0.4 to 0.5 inch and an inclined planar face 51 forming an angle of about 28 to 45 degrees with respect to the base surface 55, as shown in FIG. 23 with a designated temporary marker number 60 or as mini marker 61, as shown in FIG. 30 thru 34.Mini marker 61 is designed for use either as a low profile reflective marker with excellent retro-reflective faces, reflective marker in a recessed pavement slots or as insert in snow plow able metal casing. The primary structural support for mini marker 61 is multiple load carrying interior walls 66.

Marker 61 is injection molded using the process of present invention. Marker 61 comprises of two identical parts 61a and 61b. Each part having an inclined planar reflective face 62 with two rows of multiple reflective cells 64, two arcuate sides 65 with abrupt vertical ends, a base 63 that includes the open ends of the lower row of hollow cavity air gaps 67 and an extended portion 63b for added adhesion area, a vertical back portion 69 with the open ends of the upper row of hollow cavity air gaps 67 and a top portion 68 connected by thin ties to the corresponding opposite half.

The top portion 68 can be variable in width, depending on the size of the marker 61. Welding the two corresponding back portions 69 forms said marker 61. Load carrying interior walls 66 define the interior shapes of cells 64 and the hollow cavity air gaps 67.

The base area 63 can have a recessed portion 63a for capping and sealing the open ends of hollow cavity air gaps 67 with a corresponding size, thin and textured polymeric sheet.

Various combinations of size, height or geometric shape for markers 10,30,40, 50, 60 or 61 can be incorporated in the injection molding process of the present invention.

Preferably markers 50, 60 or 61 can have the height of the lower body 52 about 0.40 to 0.60 inches, with a base having width of about 4.0 to 5.0 inches and depth of about 2.0 to 3.0 inches.

The upper handle bar 58 of marker 50 can have various shapes and a height of about 1.00 to 1.50 inches, with overall thickness of about 0.05 to 0.20 inch. Pressure sensitive adhesives can be added to the base of all delineators or roadway markers for quick installation of said roadway markings.

In some construction applications where the need for delineator is only for few days and for one-way traffic, one side of delineator 10 or marker 50 can also be used to be effective in such applications.

FIGS. 25 thru 29 illustrate another novel, spherically shaped reflective pavement marker 30 that can be injection molded in one-step, either in one stage or two stages, utilizing the manufacturing process of the present invention. Pavement marker 30 comprises: a spherical top surface 32 with multiple parallel lined raised ridges 33, two recessed and near vertical grip sides 34, a textured planar base surface 35 that include the open ends of multiple hollow cavity air gaps 36 and 36b which are defined by means of multiple load carrying interior walls 37. The pavement marker spherical top surface 32 further includes, multiple, planar, inclined reflective cells 31. Either all of cells 31 or only the two, front and back rows can be provided with means to form, on the cells inside surfaces, multiple cube corner reflective elements protruding within the defined hollow cavity air gaps 36 and 36b.

Marker 30 can be injection molded in one stage cycle with transparent polymeric material or can be manufactured in two-stage injection molding cycle having first transparent polymer injected to fill the optical portions within cells 31, immediately followed by an opaque polymeric material to fill the remaining body.

When the two-stage injection molding process is used, the outside appearance could be similar to the marker 30, as shown in FIG.25 and 27.

Alternatively, if more transparent polymer is used or no opaque polymer injected in the second stage, then multiple of cells 31 can be formed with means to integrally include multiple cube corner reflective elements, thereby having retro reflectivity from multiple rows of cells 31 within the spherical surface 32 of marker 30, as shown in FIG.28 and 29.Various geometric shapes and number of rows of hollow cavity air gaps can be used within marker 30.The intersection corners of all load carrying interior walls 37 can be fillet to allow smooth injection molding cycles.

The mold for injection molding of marker 30 will have an open-close path parallel to the y-axis, as shown in FIG.29. This y-axis will also be near parallel to the centerline of each hollow cavity air gaps 36 and 36b, said y-axis can form an angle of about 90 to 120 degrees with respect to planar base surface 35. The mold also has an x-axis parallel to the x-axis relative to the marker 30 positions, as in FIG.29.

The load carrying interior walls 37 will have slightly outwardly tapered surface to allow uninterrupted injection molding cycle. When one stage injection molding preferred, part of the inside surfaces of the hollow cavities can have textures or grooves.

FIG.38 thru FIG.40 illustrate yet another novel, low cost, in-place filled one-piece reflective pavement marker 5 utilizing the present monolithically formed process. Marker 5 is ideally used for an in-place, combining the process of structural filling system for a pavement marker art such as U.S. Patent No.3, 332,327 to Heenan or U.S. Patent No. 4,726,706 to Attar with the process of an in-place agglutination to a roadway surface within a one step process. Marker 5 is formed to be a low cost, hollowed reflective pavement marker body ideally suited for such an in-place, combined structural filling and agglutination to a roadway surface in one step.

The one-piece marker 5 comprises of two inclined planar reflective faces 12 each having multiple reflective cells 7, two arcuate sides 12b and a sagged, arcuate top surface 12c. The sagged top surface 12c also includes a centralized open hole 9 for in-place, injection of liquefied, resinous structural material and four bleeding holes 8a. Both, the sagged top surface 12c as well as the bleeding holes 8a can control any excess material overflow during the in-place fill process. Each of cells 7 has an inside surface integrally formed with multiple cube corner reflective elements.

Marker 5 has a base surface 6 with planar portion 6c that is slightly recessed bellow a thin edge 6b, said thin edge 6b is formed as periphery to said planar portion 6c with intermittent bleeding gabs. Base surface 6 also retain the entire hollowed area beneath the reflective faces 12 and the sagged top surface 12c. The interior surfaces of the reflective cells 7 are integrally formed with multiple cube corner reflective elements. Cell 7 are defined and separated from each other by thin partition walls 7b.

Partition walls 7b has a lower region that is slightly wider and integrally provide a periphery region 7a around each reflective cell 7, thereby allowing a correspondingly shaped, thin protective plastic sheet to be welded onto each periphery region 7a slightly above the apexes of the cube corner reflective elements within each of cells 7. This tight plastic sealing sheet must protect the inside of each reflective cell 7 prior to the material fill process. Each partition wall 7b also has opening of various depth, at the center portion, allowing free flow of the fill material injected into the pavement marker during in-place agglutination and filling process.

FIG. 41 thru 43 illustrate another monolithically formed one-piece reflective pavement marker 15. Marker 15 is one-piece with a planar top 14c, two curved sides 14f each with recessed grip area 14d, two opposing, planar reflective faces 14, and planar base surface 16 with multiple load carrying partition walls 14b defining the open ends of hollow cavity air gaps 14e. The insides of cell like surfaces 14a are monolithically fabricated with multiple cube corner reflective elements. The centerlines of each hollow cavity air gap 14e form angle of about 90 to 110 degrees with respect to the planar base surface.

The present invention includes within its scope a method for making the monolithically formed reflective pavement marker comprising the steps of:

- selecting the pavement marker shape, polymers to be used, type and size of the cube corner reflective elements to be used, body shape, sizes of reflective cells used and the injection molding method to be utilized for said method of making,

- providing a tooling means which allow the injection molding of said reflective pavement marker or delineator, integrally including the cube corner reflective elements in one step, said tooling can be made to mold said marker in one stage or two stage injection molding process either in one or two colors or material zones,
- integrally providing load carrying partition wall means which allow forming multiple cube corner reflective elements within inside of each reflective cell of said pavement marker during said injection molding process,
- providing the inclined angular position of said load carrying partition wall means with respect to the planar base surface of said pavement marker to allow uninterrupted ejection cycle during said injection molding of said reflective pavement marker or delineator,
- provide a mean to apply hard abrasion resistant film utilizing one of various suitable processes such as plasma enhanced chemical vapor deposition, reactive sputtering methods or ion beam sputtering to coat the outside surface of said pavement marker or delineator with abrasion resistant hard film of either carbon, silicon dioxide or aluminum oxides film,
- provide means for in-place marker dispensing and material injection system that can have the means for multiple marker stacking hopper for guiding, dispensing and holding a marker in-place on a roadway during filling and agglutination process, one or two components polymer injection system with heating elements and control means to synchronize the above in-place dispensing, filling and agglutination process.

It is understood that various changes or modifications can be made within the scope of the appended claims to the above-preferred method of forming one-piece reflective marker without departing from the scope and the spirit of the invention. The principle processes of this invention are not limited to the particular embodiments described herein. Various embodiments can employ the processes of this invention. This invention is not limited to the exact method illustrated and described; alternative methods can be used to form the intended monolithically formed reflective pavement marker of this invention.

Therefore, the invention can be practiced otherwise than as specifically described herein.